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NUTTALL'S DEATH CAMAS (ZYGADENUS NUTTALLII) AS A POISONOUS PLANT

By C. DWIGHT MARSH, *Associate Physiologist in Charge of Investigations of Stock Poisoning by Plants;* A. B. CLAWSON, *Associate Physiologist,* and GLENWOOD C. ROE, *Junior Physiologist, Pathological Division, Bureau of Animal Industry*

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INTRODUCTION

In March, 1922, Dr. L. J. Allen, of the Bureau of Animal Industry, inspector in charge at Oklahoma City, Okla., sent to the bureau a specimen of a plant collected by Doctor Hiatt of his force in Osage County, Okla. Doctor Hiatt had been told that this plant was killing cattle in certain pastures in that county. It was stated also that the plant was not distributed very generally, but grew in patches, and that the stockmen desired to know what it was and what measures could be taken for protection.

The plant was identified as *Zygadenus nuttallii* by W. W. Eggleston, of the Bureau of Plant Industry.

In April of that year the senior author, with Doctor Hiatt, visited the locality near Pawhuska, where the plant was supposed to cause the trouble, and it was found growing in considerable abundance in some localities. Inquiry among the stockmen of the neighborhood showed that there was a general belief that this plant was the cause of rather heavy losses of cattle. It was stated that symptoms appeared in 24 hours after eating it, and that generally speaking the poisoned animals either died or recovered in from 18 to 36 hours, although some continued to be sick from 2 to 3 days to as much as 3 weeks. One man stated that a single mouthful would make a

61779°—26†

calf sick. The sick animals were salivated and vomited, and sometimes could be traced through a pasture by the material thrown out by vomiting. Mr. Walker, of Pawhuska, stated that at one time he lost 5 out of 500 and at that time 40 were sick. Mr. Craddock, of the same place, stated that one man had lost as many as 400 head of cattle.

The matter was of great interest because this was the first and only report to the Department of Agriculture of losses from this plant, although it is now well known that the species of Zygadenus growing in the West have occasioned heavy losses of livestock. It seemed a matter of some importance that the plant should be investigated experimentally, and arrangements were made for collecting material for experimental work. Unfortunately, this material was not obtained in 1922, but through the kindness of Doctors Allen and Hiatt a large quantity was collected in the spring of 1923, and the results of the experimental work with this material are recorded in this bulletin.

Very little has been known of the poisonous properties of this species. In 1840, W. J. Hooker, in Flora Boreali-Americana, vol. 2, page 177, mentions "*Leimanthium nuttallii* as being poisonous, but it is evident from the locality in which the plant was collected that the author had *Zygadenus venenosus*, not *Z. nuttallii*. The only definite reference to the poisonous properties of the species in question was made by J. U. and C. G. Lloyd in an article published in the American Druggist, 1887, vol. 16, page 141. In this article the following statement is made:

> I find it to be a powerful narcotic poison. One of my patients, a girl 8 years old, claimed that she only broke the stem of the plant and rubbed the juice on her lips and lapped it off with her tongue. Severe convulsions followed, lasting one and one-half hours, the most violent that it has been my lot to witness in a practice of 35 years; 24 hours later she had one of an hour's duration. I gave strong coffee from the start, used the bromides and gelsemium, stood over the patient three days and nights constantly. I write this that you may know there is a potency here not often met in the vegetable kingdom.
>
> *Symptoms.*—Extreme thirst, constant vomiting, dilatation of the pupil and coma, and (sequel) inflammation of the stomach.
>
> One young lady, not included in the above, says she tasted the plant and it made her very sick; she also states that the taste was fascinating and followed by a desire for more, and that it required all her will-power to resist.

The foregoing comprises all that was published of the poisonous properties of *Zyadenus nuttallii* prior to the work reported herein, with the exception of a reference by P. J. O'Gara in the Sixteenth Annual Report of the Agricultural Experiment Station of Nebraska, in which he writes of *Z. nuttallii* as occurring in Nebraska and intimates that it may be a cause of stock losses.

DESCRIPTION OF THE PLANT[1]

Zygadenus nuttallii.—The stems are stout, 1 to 2 feet high; the bulbs are ovate. The leaves are from 4 to 20 inches long, one-fourth to three-fourths inch wide, and somewhat curved; the upper leaves are shorter and the lower are sheathed at base. The flower clusters are simple or branched and rather densely flowered. The flowers are whitish or yellowish; the bracts are about the length of the pedicels and are narrow and thin; the flower segments are from

[1] The description was prepared by W. W. Eggleston, of the Bureau of Plant Industry.

one-fourth to three-eighths inch long and free from the seed pod; the glands are roundish and rather ill defined; the stamens are somewhat longer than the flower segments. The seed pods are about one-half inch long, three beaked, and three celled, splitting along the juncture of the cells. The seeds are numerous, flattened, and about one-fourth inch long.

The plant was discovered near Fort Smith, Ark., by Thomas Nuttall in 1819.

Its known range is in the upland prairie from Riley County, Kans., south to the southern limits of the Edwards Plateau, Tex., as shown in the map, Figure 1.

FIG. 1.—Distribution of Nuttall's death camas (*Zygadenus nuttallii*)

It is replaced in the Great Plains by *Z. gramineus*, from which it can be distinguished by a more robust habit, stamens exceeding the flower segments, flower clusters branched, and upper leaves usually sheathless.

In Plate I is shown the plant in flower and in seed.

EXPERIMENTAL WORK

During the summer of 1923 *Zygadenus nuttallii* was fed to 7 cattle and 16 sheep. All but one of the animals were more or less affected by the plant and two died. Dried plant was used in all cases, but the toxic and lethal doses were computed as green plant and in terms of percentages of animal weight. In one of the fatal cases, sheep 759, the animal was previously diseased and the plant was only a contributory cause of death. All but two of the sheep were fed by balling gun. Table 1 gives the general data of the experiments.

TABLE 1.—*Summary of feeding experiments with Zygadenus nuttallii, 1923*

Animal		Date of feeding	Method of feeding	Part of plant used	Actual quantity given	Per cent of animal weight fed[1]		Average daily dosage	Place and date of plant collection	Result	Remarks
Designation	Weigh					Green	Dry				
	Pounds				*Pounds*			*Pounds*			
Cattle Nos.:		Aug.									
965	518	8–9	In hay	Leaves, stems, and young flowers.	0.324	0.25	0.0625	0.125	Pawhuska, Okla., June, 1923.	Symptoms	0.25 per cent animal weight eaten in 2 days produced symptoms Aug. 10.
995	538	8–11	do	do	.672	.5	.125	.125	do	do	0.44 per cent animal weight eaten in 2 days produced symptoms Aug. 10.
982	470	19–22	do	do	.882	.75	.1875	.1875	do	do	0.62 per cent animal weight eaten in 1 day; produced symptoms Aug. 20.
974	530	30–31	do	do	1.325	1.	.25	.5	do	do	0.5 per cent animal weight eaten in 1 day; produced symptoms Aug. 31.
		Sept.									
983	530	9	do	do	1.28	.964	.241	.964	do	Sick	
971	574	11–13	do	do	1.5	1.046	.261	.349	do	Symptoms	Symptoms after eating 0.78 per cent of animal weight in 1 day, green equivalent.
997	442	18	do	do	1.105	1.	.25	1.	do	Sick	Eaten in 1 hour.
Sheep Nos.:		July									
741	90.75	18	Balling gun	do	.227	1.	.25	1.	do	Very sick	
746	83.5	22	do	do	.104	.5	.125	.5	do	Sick	
748	79.5	26	do	Bulbs	.149	.344	.086	.344	do	Somewhat sick	When fed, the bulbs contained 54.05 per cent moisture.
752	110	28	do	do	.31	.516	.129	.516	do	Very sick	Do.
		Aug.									
715	84.5	1	do	do	.139	.266	.066	.266	do	Symptoms	When fed, the bulbs contained 59.8 per cent moisture.
727	90.5	14	do	Leaves, stems, and young flowers.	.169	.75	.187	.75	do	Sick	
736	90	23–26	In hay	do	.192	.852	.213	.213	do	Symptoms	0.388 per cent animal weight produced symptoms Aug. 24.
		Sept.									
714	124	1–3	do	do	.31	1.	.25	.333	do	do	0.6 per cent animal weight produced symptoms Sept. 2.
720	82	5	Balling gun	Bulbs	.233	.55	.137	.55	do	Very sick	When fed, the bulbs contained 51.55 per cent moisture.

752	110	6	do	Leaves, stems, and young flowers.	.264	.96	.24	.96	do	do	
726	100	7	do	do	.063	.25	.063	.25	do	Somewhat sick	
755	122	10	do	do	.055	.18	.045	.18	do	Symptoms	
759	133	10	do	Bulbs	.086	.125	.031	.125	do	Death	Death only partially due to Zygadenus.
761	122	10	do	Leaves, stems, and young flowers.	.038	.125	.031	.125	do	Not sick	
721	96	12	do	do	.288	1.2	.3	1.2	do	Death	
712	78.5	13	do	Bulbs	.035	.09	.0255	.09	do	Symptoms	When fed, the bulbs contained 50 per cent moisture.

[1] 75 per cent allowed for loss in drying.

TYPICAL CASE OF SHEEP 741

Sheep 741 was a 3-year-old ewe, which was brought in from the pasture for observation on July 16, 1923.

July 18, between 11.25 and 11.40 a. m., the sheep was given by balling gun 102.9 grams of dry leaves, stems, and young flowers of *Zygadenus nuttallii*. This was an equivalent of 1 pound of green plant per 100 pounds of animal weight.

1.00 p. m.—The respiration was deeper than before the feeding, and there was occasional licking of lips as though the secretion of saliva had been increased.

2.30 p. m.—Distinct salivation appeared.

2.36 p. m.—Respiration was irregular and deep, and there was some trembling of the flanks during expiration.

3.35 p. m.—The respiration was somewhat labored and the animal showed slight weakness in the hind limbs.

5. 25 p. m.—The weakness was somewhat increased, as shown by the fact that the animal stood with the hind feet braced. The salivation continued and the animal was markedly depressed.

8.50 and 8.55 p. m.—The respiration was accompanied by groaning. The animal at this time could stand.

9.20 p. m.—The pulse was 200 and very weak. The animal was lying down with the head to one side, and there were occasional spasmodic movements of the muscles of the hips and flanks.

10.06 p. m.—The pulse was about 80 and stronger than at 9.20, but the general condition of the animal was unchanged. The groaning was continued.

11 and 11.50 p. m.—The animal appeared somewhat better, but the groaning continued, and she was weak in the hind legs.

July 19, 6.45 a. m.—The condition was nearly the same as when observed the preceding night at 11.50. The respiration was irregular but somewhat spasmodic, the expiration being accompanied by groans. Plate II, Figure 1, shows her condition at 8.25 a. m. The condition continued very nearly the same during the day. Although able to stand, she was down most of the time and was much salivated.

4.52 p. m.—She showed less weakness and indications of some improvement.

July 20, 7.14 a. m.—She was much better, with a weak but regular pulse, and most of the indications of extreme weakness had passed. She continued to improve during the day and ate a little hay. From this time there was gradual improvement, the animal became stronger, the pulse and respiration became natural, and on the morning of July 24 she was turned out, having made practical recovery.

Another sheep, No. 727, is shown in Plate II, Figure 2, in a condition of general weakness.

TYPICAL CASE OF CATTLE 997

Cattle 997 was a young heifer weighing 442 pounds at the time of the experiment. She was taken in from the pasture September 15 and kept under observation in the corrals.

September 18.—At 9.45 a. m. she was given 501.2 grams of dry leaves, stems, and flowers of *Zygadenus nuttallii* ground up and mixed with alfalfa hay. This quantity was the equivalent of 1 pound of green plant per 100 pounds of animal. At 10.40 a. m. all

ZYGADENUS NUTTALLII

The form of the plant is shown both in flower and in seed

FIG. 1.—SHEEP 741, AT 8.25 A. M., JULY 19

FIG. 2.—SHEEP 727, IN A CONDITION OF GENERAL WEAKNESS

FIG. 3.—CATTLE 997, STAGGERED WHEN WALKING, AND WHEN HURRIED NEARLY FELL, 11.30 A. M., SEPTEMBER 19

FIG. 4.—CATTLE 997, AT 10 A. M., SEPTEMBER 20; MUCH IMPROVED

the feed had been eaten. The animal was kept under observation during the rest of the day and showed nothing abnormal. When offered hay at 5 p. m. she ate it with considerable eagerness.

September 19.—At 6.30 a. m. she was found lying down and had vomited during the night. At 8.45 a. m. the temperature was 100.7° F., the pulse 44 but very weak and irregular, and the respiration 16, of a normal character. The animal could get upon her feet at this time, but was very uncertain in her movements. She had been vomiting since the preceding observation at 6.30. At 11.30 a. m. the animal was found lying down but after some effort got upon her feet. She staggered when walking and when hurried very nearly fell. Plate II, Figure 3, shows very clearly this condition of weakness. She had not, however, at this time lost all her appetite for hay. During the rest of the day she continued in much the same condition, although late in the afternoon she was unable to get upon her feet. At 8.45 p. m. she was found on her feet and ate, although she appeared to be much depressed.

September 20.—At 8.40 a. m. the temperature was 98.2° F., pulse 48, respiration 20. The pulse was regular but weak. During the observation she was lying down and showed no desire to get upon her feet. After some forcing she got up, but had very little control of her legs. Between 10 and 11 a. m. she seemed much improved and could walk, although the movements were stiff and weak, with some staggering. Plate II, Figure 4, taken at 10 a. m., shows the animal upon her feet, but her weakness is indicated in the position of the hind legs, which are braced rather far apart. There was no great change during the day. In the observation taken at 5.05 p. m., the pulse was still weak but was regular.

September 21.—At 8.50 a. m. the pulse was still weak and the animal in walking showed a little weakness. She gained in strength, however, during the day, and in the observation at 4.10 p. m. the pulse was strong, regular, and normal.

On the morning of September 22 the animal was practically recovered and was turned into the pasture.

The symptoms exhibited were for the most part typical but it should perhaps be noted that in this animal there was no distinct lowering of the temperature.

RESULTS OF EXPERIMENTAL WORK AND CONCLUSIONS

SYMPTOMS

Salivation.—Salivation is very nearly a universal symptom of the poisoned animals. This was noted in 3 of the 7 experimental cattle and in all but 2 of the experimental sheep. In most cases, this is the first evidence of intoxication.

Nausea.—Nausea is almost invariably present and is frequently accompanied by vomiting. Vomiting was exhibited in all the cattle but in only two of the experimental sheep. In many cases the vomiting occurs not only once but repeatedly.

Depression and weakness.—In mild cases the animals show only depression. When the illness is more pronounced it is accompanied by weakness which is especially noticeable in the hind legs; in the more severe cases the animals stagger when attempting to walk and may sometimes be unable to rise. Plate II illustrates this condition in

sheep and cattle. In the worst cases it culminates in coma, which may continue for a prolonged period before recovery or death.

Temperature.—In most cases, of both cattle and sheep, the period of poisoning is one of definite low temperature. This is particularly marked in the case of the sheep. The temperature is not extremely low, but is distinctly below normal and rises again with the recovery from the illness. Figure 2 shows the temperature curve of sheep 748 and Figure 3 that of sheep 752.

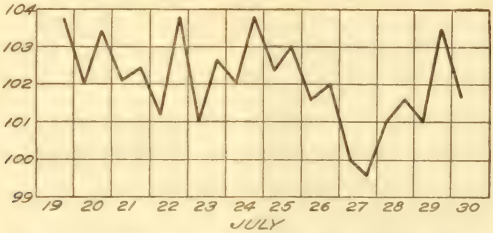

FIG 2.—Temperature curve of sheep 748, showing effect of *Zygadenus nuttallii*. Plant was fed July 26. Note severe depression in temperature the following day

Pulse and respiration.—In most cases the pulse is weak and more or less irregular. The rate varies, but ordinarily is not rapid for any prolonged time. The respiration is distinctly irregular. This irregular respiration, in severe cases, is accompanied by grinding of the teeth and groans.

Effect upon feces.—There is not, in all cases, any marked effect upon the excreta. Sometimes, however, the feces are soft and contain more or less mucus.

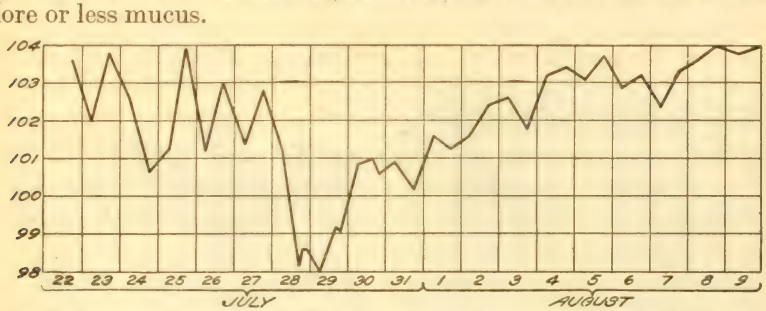

FIG. 3.—Temperature curve of sheep 752, showing effect of *Zygadenus nuttallii*. Plant was fed in forenoon of July 28. Rapid depression in temperature, lasting several days, occurred

Anorexia.—As would be expected in all severe cases, there is a more or less complete loss of appetite.

The foregoing description of the symptoms of poisoning with *Zygadenus nuttallii* shows that the results of the poisoning by this plant are practically identical with those produced by other species of Zygadenus. As described in U. S. Department of Agriculture Bulletins 125, 1012, and 1240, it appears that the effect of *Z. nuttallii* is practically identical with that produced by *Z. elegans, Z. gramineus, Z. paniculatus,* and *Z. venenosus.*

TIME BETWEEN FEEDING OF PLANT AND DEVELOPMENT OF SYMPTOMS

In the case of cattle the feeding generally continued through a considerable period and it was not possible to tell just when the feeding was completed. In the sheep, on the other hand, the plant was

given in a single feeding, so that it was possible to tell with considerable exactness the time elapsing between the feeding and the appearance of symptoms. Table 2 shows this time in the case of the sheep.

TABLE 2.—*Time between feeding of plant and development of symptoms in sheep*

Sheep No.	Time elapsed before symptoms		Sheep No.	Time elapsed before symptoms	
	Hours	*Minutes*		*Hours*	*Minutes*
741	1	20	726	4	45
746	21	44	755	3	22
748	26	54	759	2	13
752	1	44	721	1	56
715	5	5	712	25	10
727	0	29			
720	5	0	Average	7	45
752	1	9			

The longest period was in the case of sheep 748, 26 hours and 54 minutes. The shortest time was in sheep 727, 29 minutes.

COMPARISON OF SPECIES OF ZYGADENUS IN REGARD TO THE TIME BEFORE DEVELOPMENT OF SYMPTOMS

In Bulletin 1240 is a table in which is compared the time of the development of symptoms in the species of Zygadenus which had been studied up to that time. For the purpose of comparison that table is reproduced here with the addition of the data in regard to *Z. nuttallii*, as Table 3.

TABLE 3.—*Minimum, maximum, and average time elapsing between the feeding of Zygadenus to sheep and development of symptoms*

Species of Zygadenus	Minimum	Maximum	Average
Z. paniculatus	55 minutes	8 hours 40 minutes	3 hours 14 minutes.
Z. elegans	Immediately	7 hours	1 hour 53 minutes.
Z. venenosus	44 minutes	9 hours 40 minutes	2 hours 25 minutes.
Z. gramineus	5 minutes	7 hours 30 minutes	1 hour 22½ minutes.
Z. nuttallii	29 minutes	26 hours 54 minutes	7 hours 45 minutes.

It was noted in Bulletin 1240 that there was no material difference in the time of development of symptoms between the species *Zygadenus paniculatus*, *Z. elegans*, *Z. venenosus*, and *Z. gramineus*. It may be a matter of some interest that, though the minimum time of development of symptoms in *Z. nuttallii* was practically the same as that in the other species, the maximum and average were considerably greater. Whether any special significance should be attached to this fact may be a matter of question, but it seems evident that the effects of this species do not appear so soon as do those produced by the species reported in the earlier bulletins.

DURATION OF SICKNESS

Table 4 shows the time during which the sickness continued. As this is estimated from the first noted symptom to the last, the time in most cases is probably somewhat less than that during which the

animals suffered. In this table are included not only the animals which recovered but the two which died.

TABLE 4.—*Duration of sickness*

Animal	Duration of symptoms			Animal	Duration of symptoms		
Cattle Nos.:	*Days*	*Hours*	*Minutes*	Sheep Nos.:	*Days*	*Hours*	*Minutes*
965[1]				727	2	2	19
995	2			736		8	10
982	2	1	25	714		1	42
974	2			720	4	21	21
983	1	21		752	3		
971	1	3		726		16	21
997	2			755		21	
Sheep Nos.:				759	3	14	
741	2	1	18	721			14
746		5		712[2]			
748		18	55	Average, cattle	1	13	55
752	9	19	50	Average, sheep	2		41
715	2						

[1] One observation. [2] One observation.

The average duration in the case of cattle was 1 day, 13 hours, and 55 minutes, with a maximum of 2 days, 1 hour, and 25 minutes and a minimum of a single observation. The average in the case of sheep was 2 days and 41 minutes, with a maximum of 9 days, 19 hours, and 50 minutes, and a minimum of a single observation.

If this table is compared with the data in the general table, it will be seen that the duration of sickness was greatest in those animals which suffered most severely. The average of the cattle is about three-fourths that of the sheep. It may be noted in this connection that the cattle were not so severely affected as the sheep.

COMPARISON OF DURATION OF SYMPTOMS IN SPECIES OF ZYGADENUS

In Bulletin 1240 is shown a comparative table of the duration of illness from four species of Zygadenus. That table is repeated here, with the addition of the data in regard to the sheep poisoned by *Zygadenus nuttallii*, as Table 5.

TABLE 5.—*Duration of illness in cases of sheep poisoned by species of Zygadenus*

Species of Zygadenus	Maximum	Minimum	Average
Z. gramineus	79 hours 20 minutes (died); 68 hours 20 minutes (recovered).	1 observation	12 hours 1 minute.
Z. paniculatus	96 hours	do	36 hours 2 minutes.
Z. elegans	20 hours 6 minutes	do	5 hours 19 minutes.
Z. venenosus	90 hours 5 minutes	do	29 hours 16 minutes.
Z. nuttallii	235 hours 50 minutes	do	48 hours 41 minutes.

If compared with the other species, it will be noted that apparently sheep poisoned by *Zygadenus nuttallii* have a longer period of illness.

AUTOPSY FINDINGS

Only one sheep died as a direct result of the feeding of *Zygadenus nuttallii*. The autopsy on this animal gave entirely negative results, probably owing to the short time which elapsed between the feeding and death.

The microscopic examination of the tissues of this animal was nearly as barren of results as the autopsy. In the alimentary canal no alteration of significance was found unless a mild edema and the presence of a somewhat unusual number of lymphocytes in the corium and, to some extent, in the submucosa of the rumen may be considered as indicating a slight irritation.

Of the various glandular organs the kidneys alone were affected and in them the changes were mild in character. Both kidneys were somewhat congested, shown mainly in the veins and intertubular capillaries of the cortex. The epithelium of the convoluted tubules was somewhat swollen and granular, and showed some slight tendency to disintegrate. The nuclei, however, were well stained.

Nothing was found in this animal which disagrees with the changes described in cases of poisoning by other species of Zygadenus.

TOXIC AND LETHAL DOSAGE

Sheep.—The smallest quantity of stems, leaves, and flowers producing intoxication was in the case of sheep 755, which was poisoned on 0.18 per cent of its weight. As sheep 761 received 0.125 per cent without effect, it may be presumed that 0.18 per cent is about the minimum toxic dose.

Sheep 712 was poisoned by 0.09 per cent of its weight of bulbs.

Sheep 721 was killed by 1.2 per cent of its weight of stems, leaves, and flowers, and sheep 741 was made very sick by 1 per cent. It seems probable that 1.2 per cent is not far from the minimum lethal dose.

Sheep 759 died after receiving 0.125 per cent of its weight of bulbs, but this sheep was diseased and its death was only in part due to the *Zygadenus nuttallii*. As sheep 752 was made very sick on 0.516 per cent of its weight, it seems probable that the minimum lethal dose of bulbs is somewhat greater than 0.516 per cent.

In Bulletin 1240 were tabulated the data for the comparative toxicity of the species of Zygadenus which had been studied up to that time. Comparing with this table such facts as we have in these experiments, it appears that *Z. nuttallii* is much more poisonous than the western species.

Cattle.—The cattle upon which the experiments were made received the plant with hay and ate it during a period varying from one to four days. Under such circumstances, we should expect the dosage to be somewhat larger than in the case of the sheep which received the plant by single forced feedings.

All the experimental cattle received feedings of the whole plant. The smallest quantity which produced symptoms was in the case of cattle 965, which was poisoned by 0.25 per cent of animal weight. This was fed in two days, 0.14 per cent being received the first day and 0.11 per cent the second day. Cattle 995 was poisoned on 0.44 per cent of its weight. This was also eaten in two days, 0.22 per cent being eaten on each day.

There were no cattle killed in the course of the experiments. Cattle 997 received 1 per cent of its weight, which was eaten in an hour's time and produced sickness, which would indicate that the lethal dose was something over 1 per cent of the animal weight.

The results with experimental cattle, although not very definite in regard to either toxic or lethal dosage, would indicate the probability

that cattle do not differ materially from sheep in susceptibility to poisoning by *Zygadenus nuttallii*.

The results with cattle 965 and cattle 995 are somewhat interesting, in that symptoms were noted only after the second day's feeding. It would seem that the toxic substance of the first day's feeding was not eliminated before the second day, and that the sickness resulted to some extent from the combined feedings of the two days.

COMPARATIVE TOXICITY OF PARTS OF THE PLANT

The number of experiments upon bulbs was not large enough to make conclusive inferences in regard to the toxicity of the bulbs as compared with the other parts of the plants, but the experiments do indicate that the bulbs are somewhat more toxic than the parts of the plants above ground. This is a matter of considerable interest, as preceding work on the other species of Zygadenus indicated that *Z. venenosus* was the only one in which the bulbs were definitely more toxic than the other parts of the plant.

ANIMALS SUSCEPTIBLE TO POISONING

The experimental work showed that cattle and sheep may be poisoned by this plant. There were no experimental feedings of horses, but it is probable that this death camas, like the others, will poison horses. It is also probable that, as was shown in Department Bulletin 1240 to be the case with *Z. venenosus*, swine will vomit with sufficient promptness so that they will not suffer severely from Nuttall's death camas.

PROBABILITY OF DEATH OF LIVESTOCK

The toxic dose, as shown on page 11, is small and it is evident that animals may easily be made sick by eating the plant, but the lethal dose is fairly large, though only one-half that of *Z. paniculatus* or *Z. venenosus*. A 100-pound sheep, for instance, must eat about a pound to produce death. A sheep may readily eat that quantity, but it is not likely, in the presence of other feed, to confine itself to any one plant. Therefore, the probabilities are that comparatively few sheep, unless forced by hunger, will eat enough to produce death. To use a physician's term, the prognosis of most poisoned sheep is good; that is, with reasonable care they probably will recover.

Cattle do not seek so much variety in their forage, but it may be expected that most of those made sick will recover.

REMEDIAL MEASURES

As in the case of the other forms of death camas, there is no effective medicinal remedy known. The plant, so far as known, grows in somewhat limited areas, so that stockmen who recognize the danger can, by proper care, keep their animals away from these areas during the dangerous period. The plant comes up before the grasses and is said to disappear in a few weeks' time. It is easily recognized, and, for the most part, can be avoided.

As stated before, if animals are poisoned it does not necessarily follow that they will die; a large proportion will probably recover. It is important that sick animals should be kept quiet and fed if they show a desire to eat. It is possible that some laxative like linseed oil would aid in the elimination of the poison.

SUMMARY

Nuttall's death camas (*Zygadenus nuttallii*) has not been recognized hitherto as a stock-poisoning plant. It appears that it has occasioned considerable losses of cattle in parts of Oklahoma, and probably it is the cause of many unexplained cases of sickness and death in the region where it is found.

The symptoms of sickness are like those produced by other species of death camas.

It is even more poisonous than the western species which have been the subject of study.

There are no effective medicinal remedies, but losses may be lessened by keeping animals, so far as possible, from the plant, and giving proper attention to sick animals.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

January 15, 1926

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